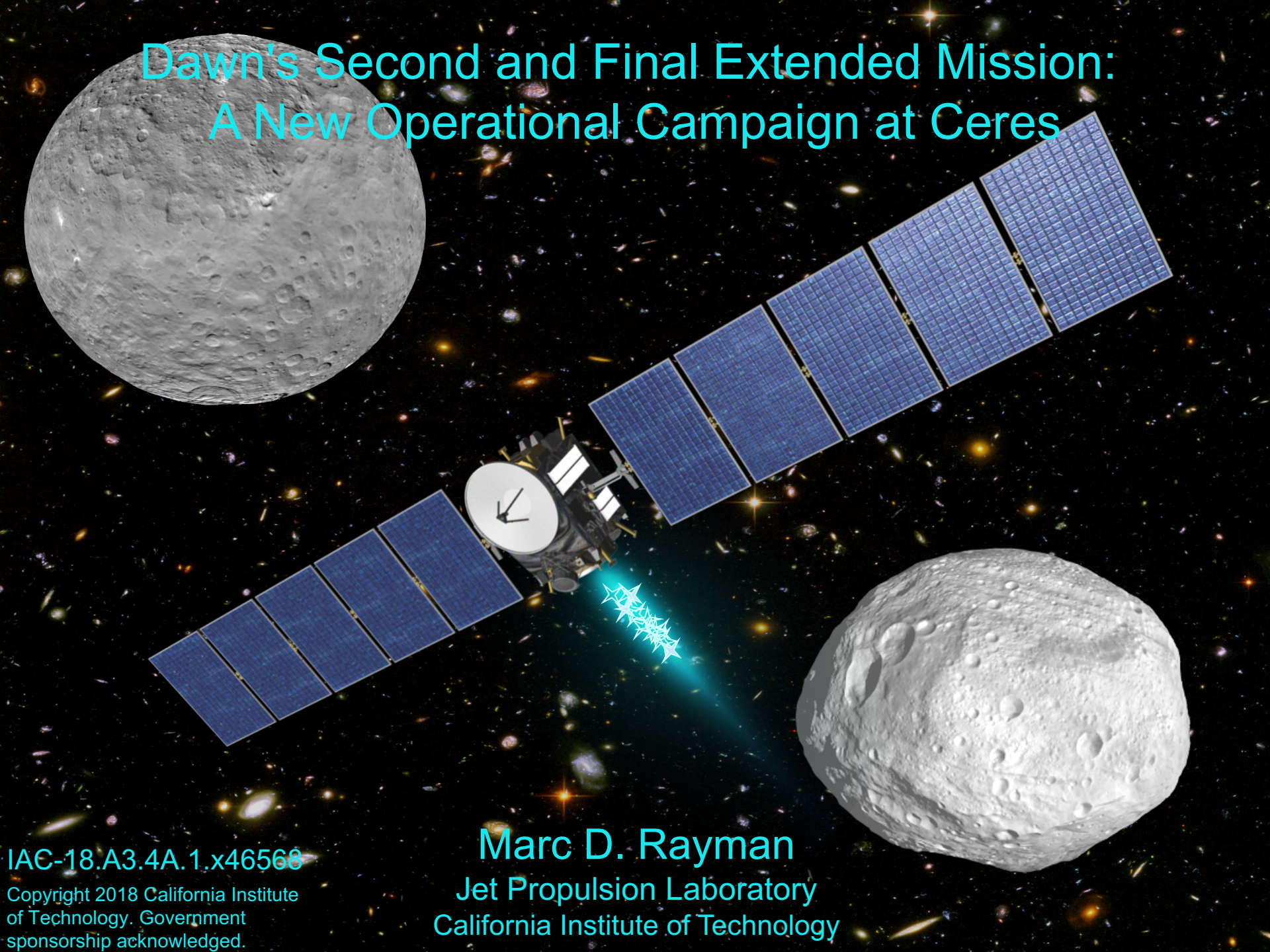
Dawn's Second and Final Extended Mission: A New Operational Campaign at Ceres



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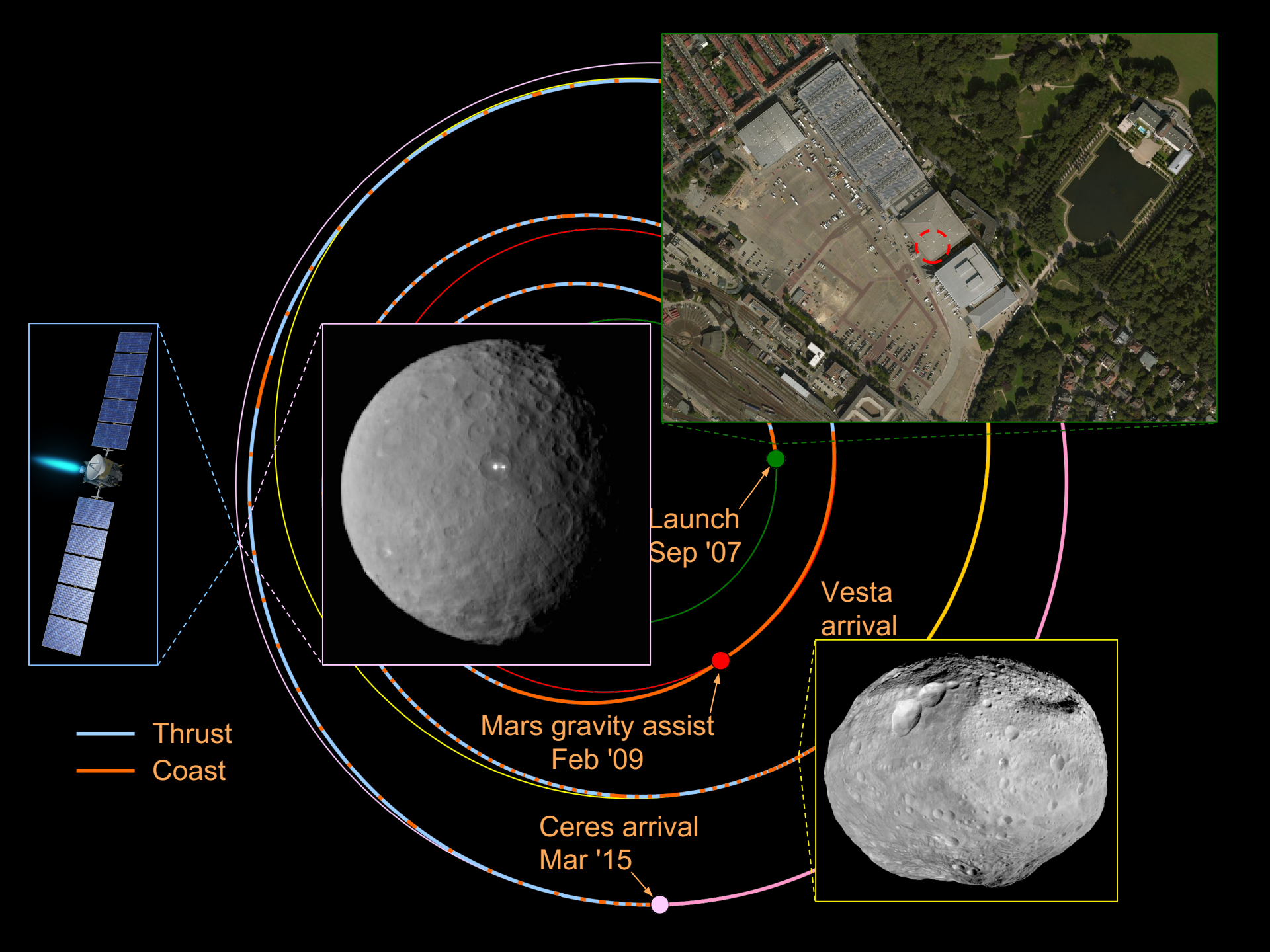
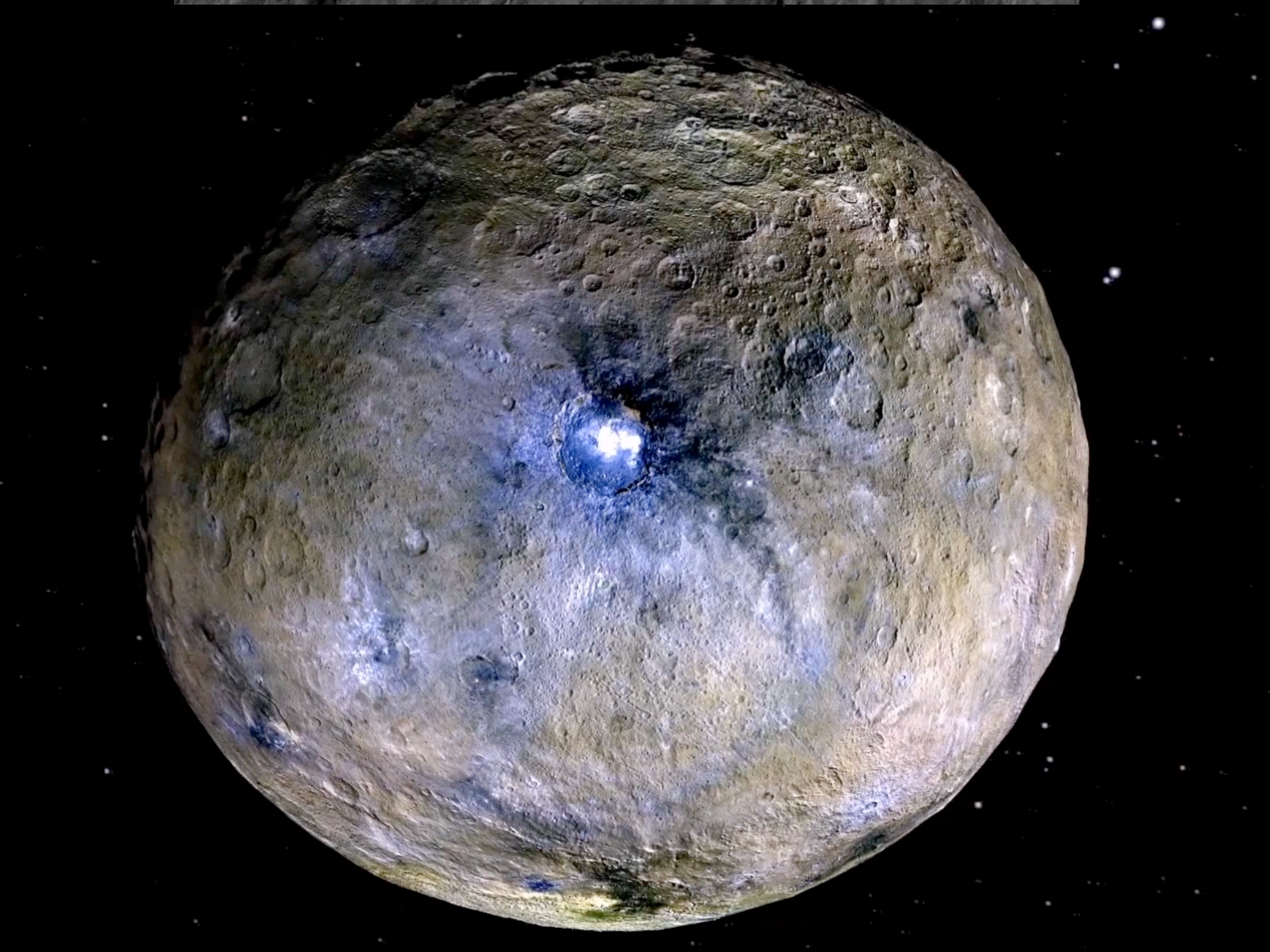
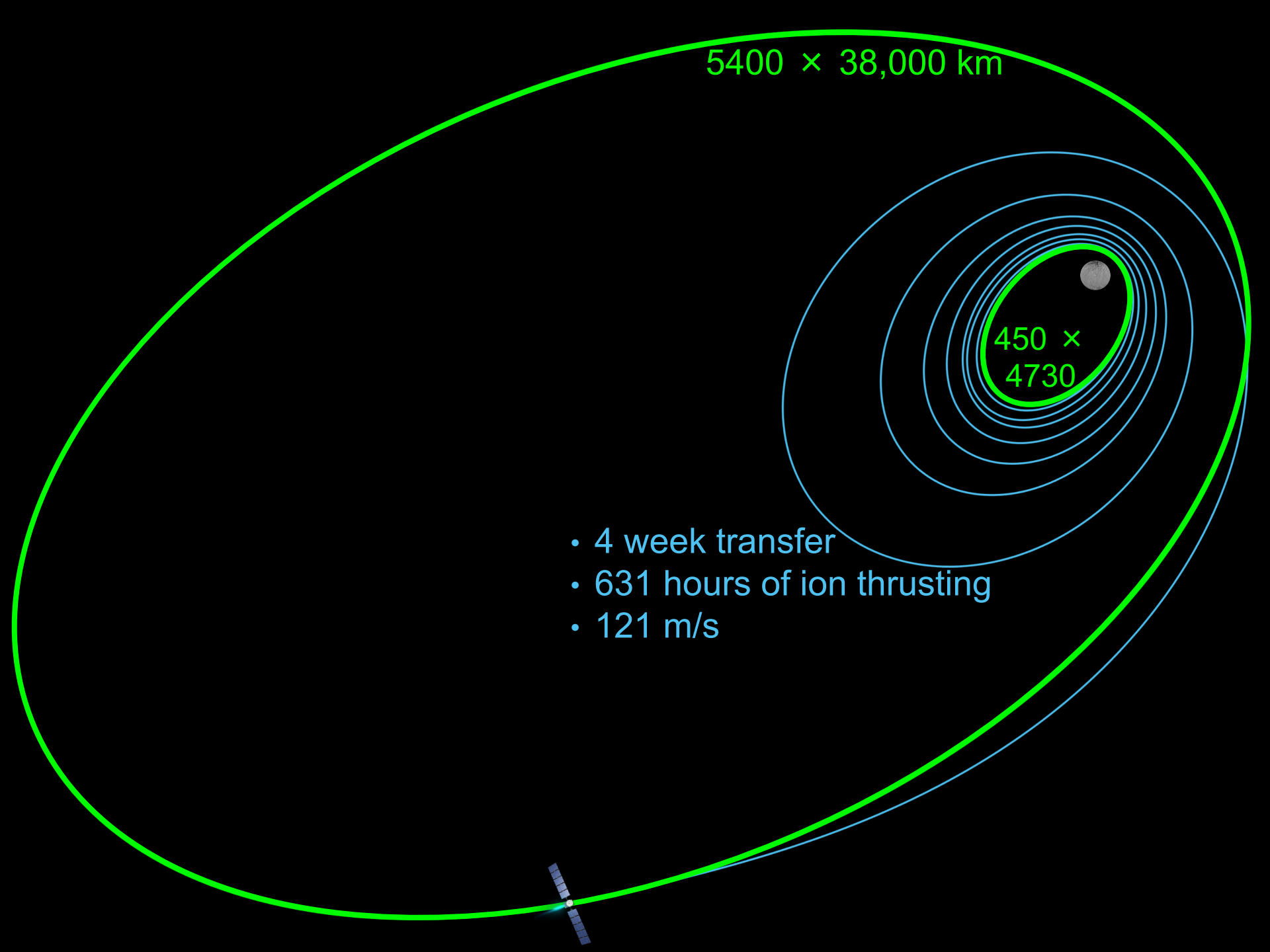
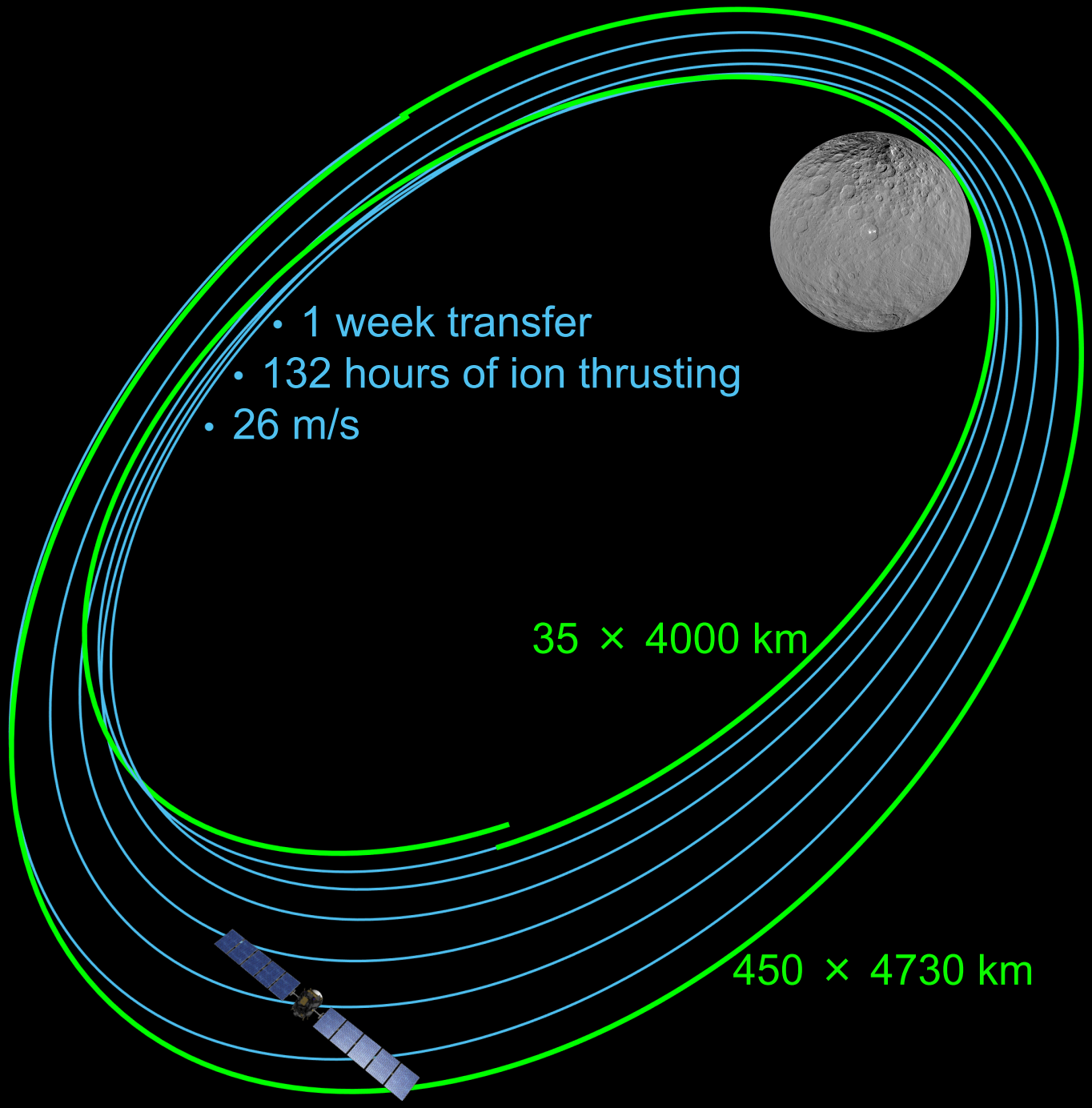
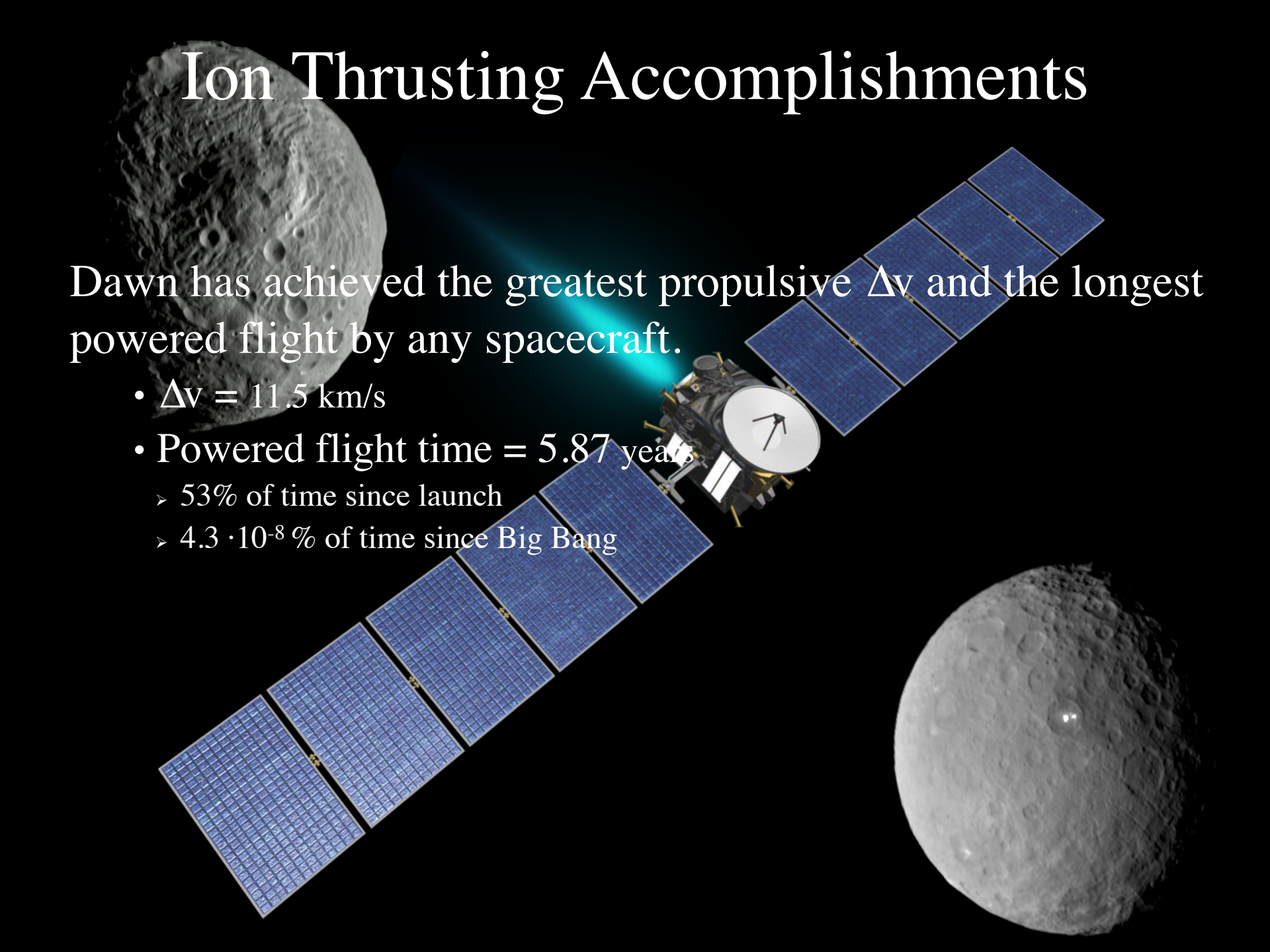

Launch
Sep '07
Vesta
arrival
Mars gravity assist
Feb '09
Ceres arrival
Mar '15
Thrust
Coast




5400 × 38,000 km
450 × 4730
• 4 week transfer
• 631 hours of ion thrusting
• 121 m/s


• 1 week transfer
• 132 hours of ion thrusting
• 26 m/s
35 × 4000 km
450 × 4730 km

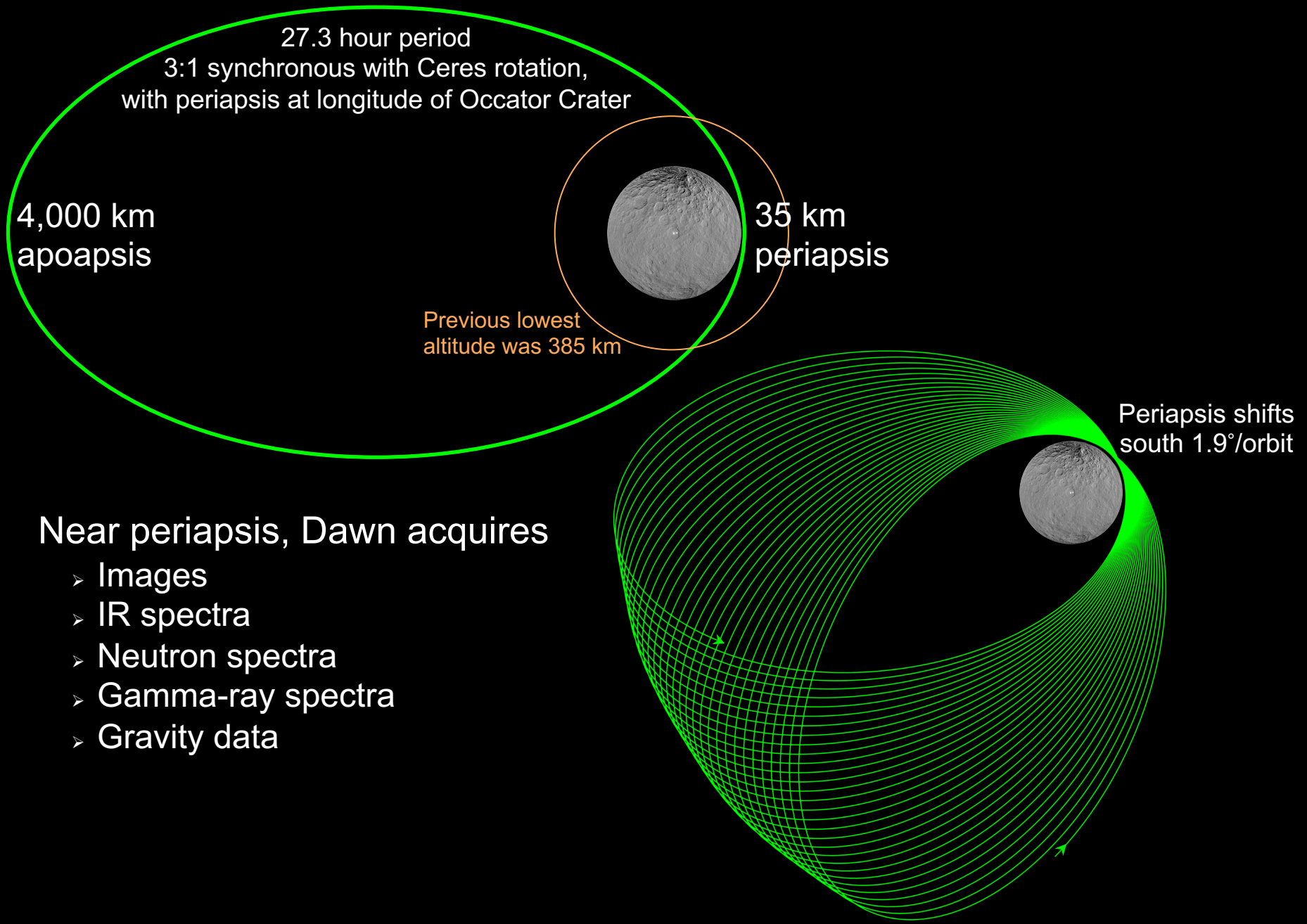
Ion Thrusting Accomplishments



Dawn has achieved the greatest propulsive Δv and the longest powered flight by any spacecraft.

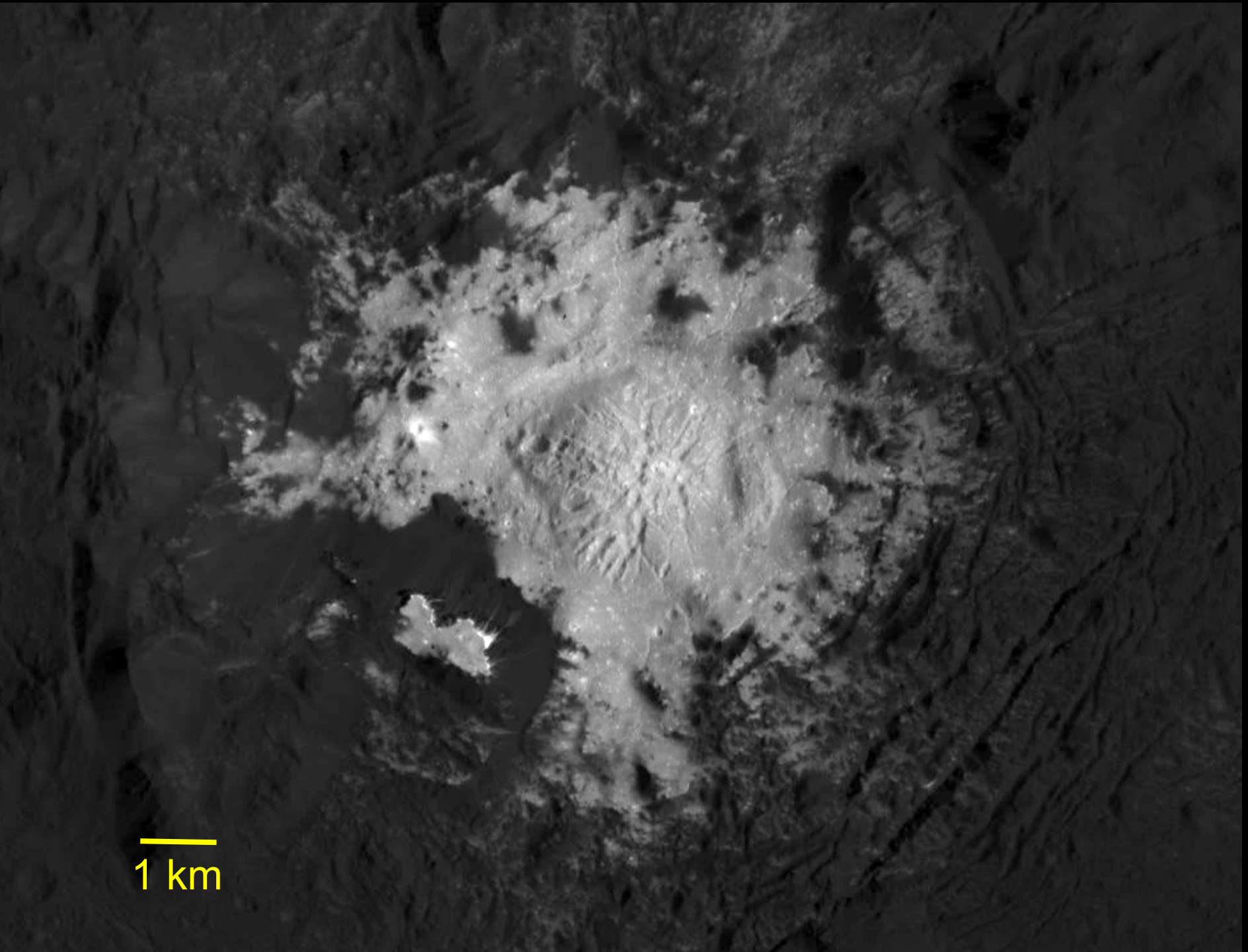
- Δv = 11.5 km/s
- Powered flight time = 5.87 years
  - 53% of time since launch
  - $4.3 \cdot 10^{-8}$ % of time since Big Bang

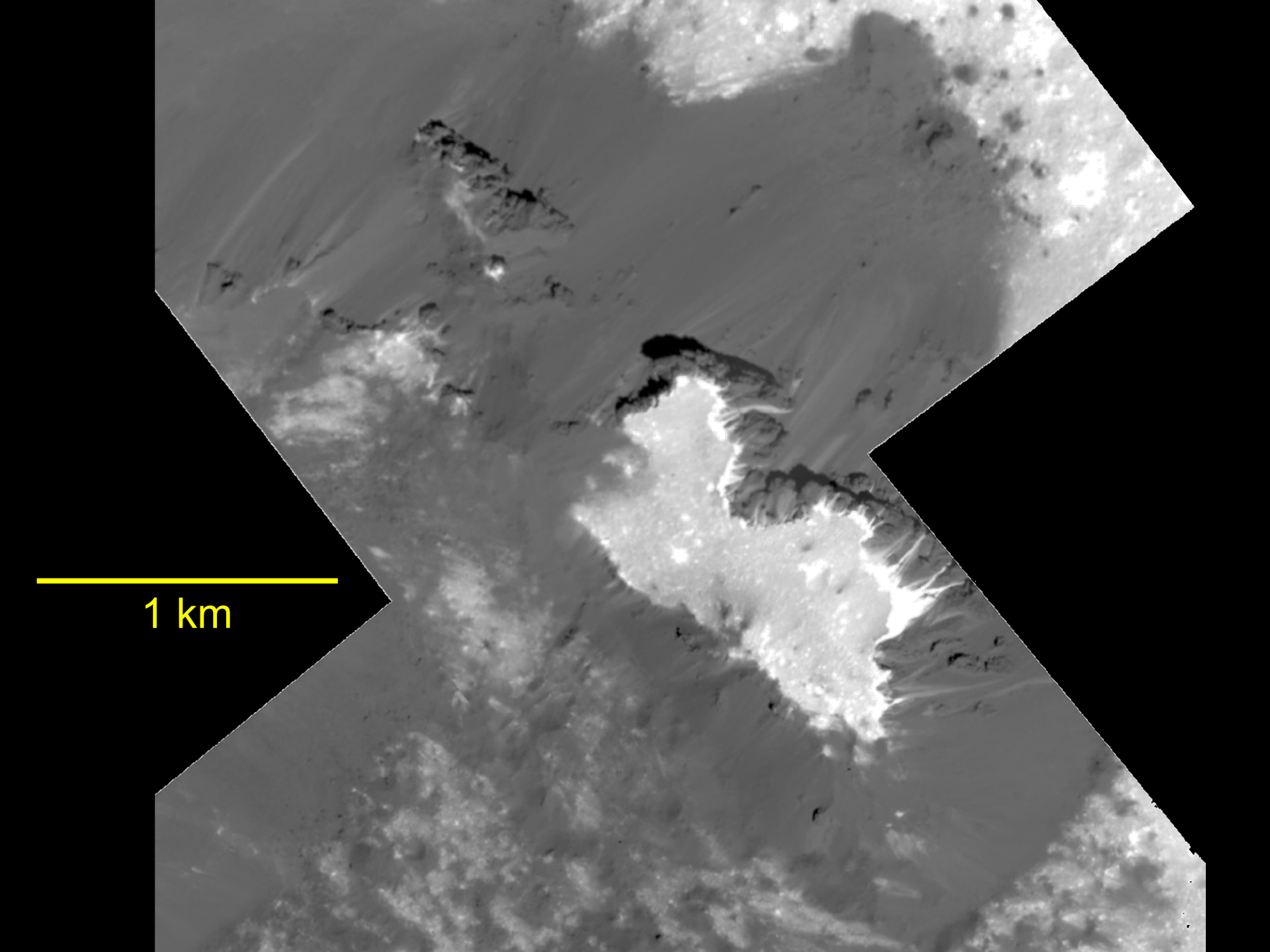
Dawn's Current (and Final) Orbit

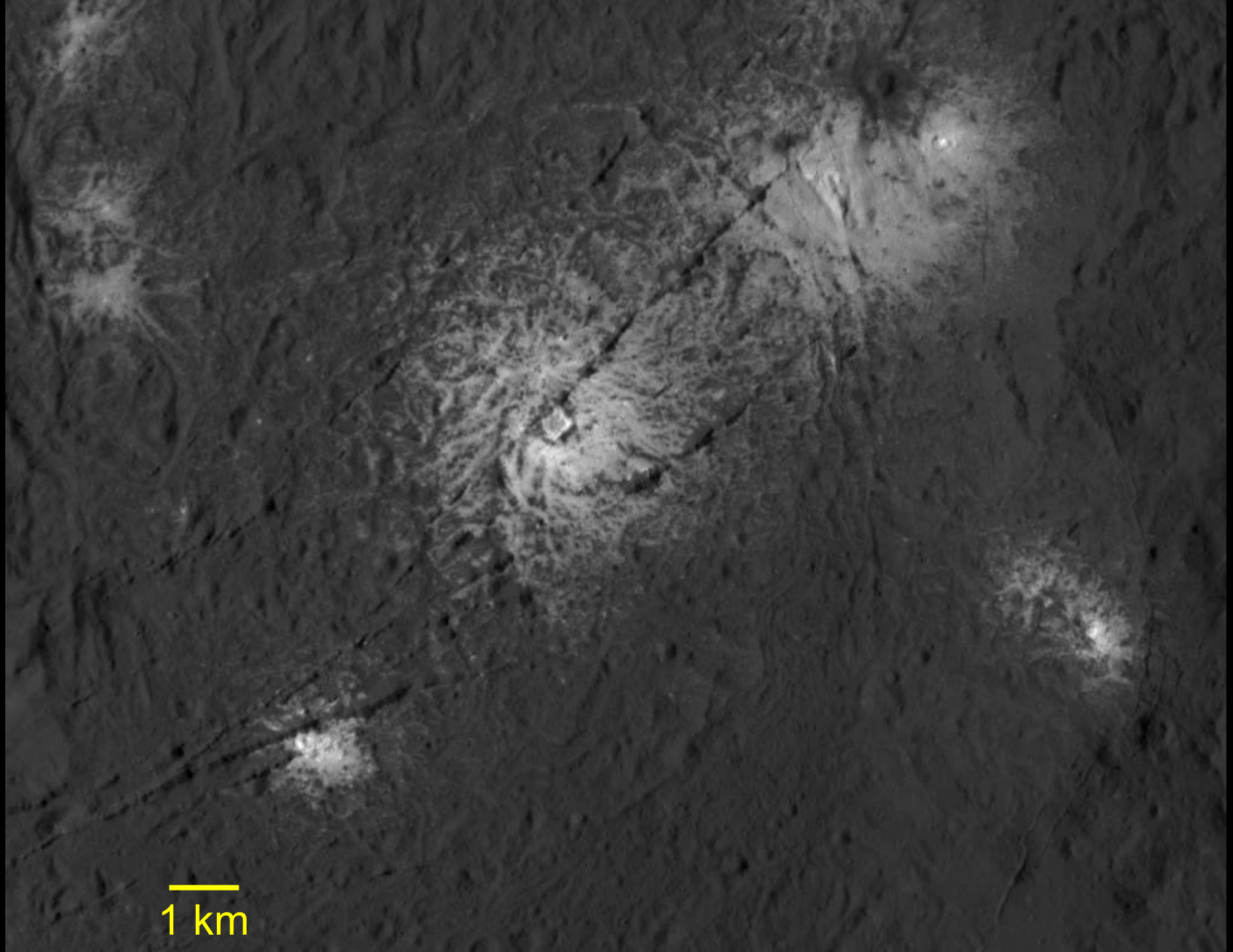


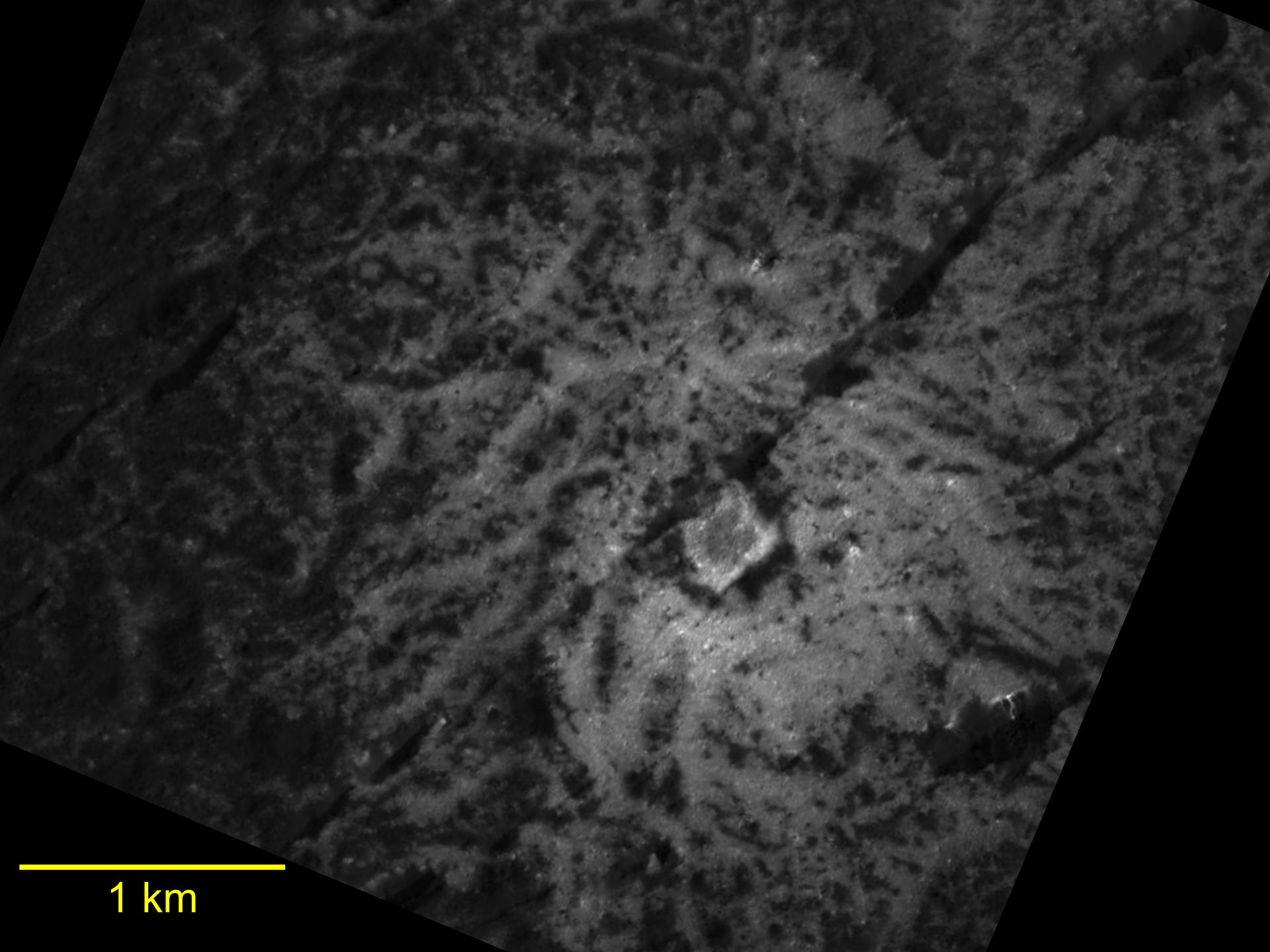
Near periapsis, Dawn acquires

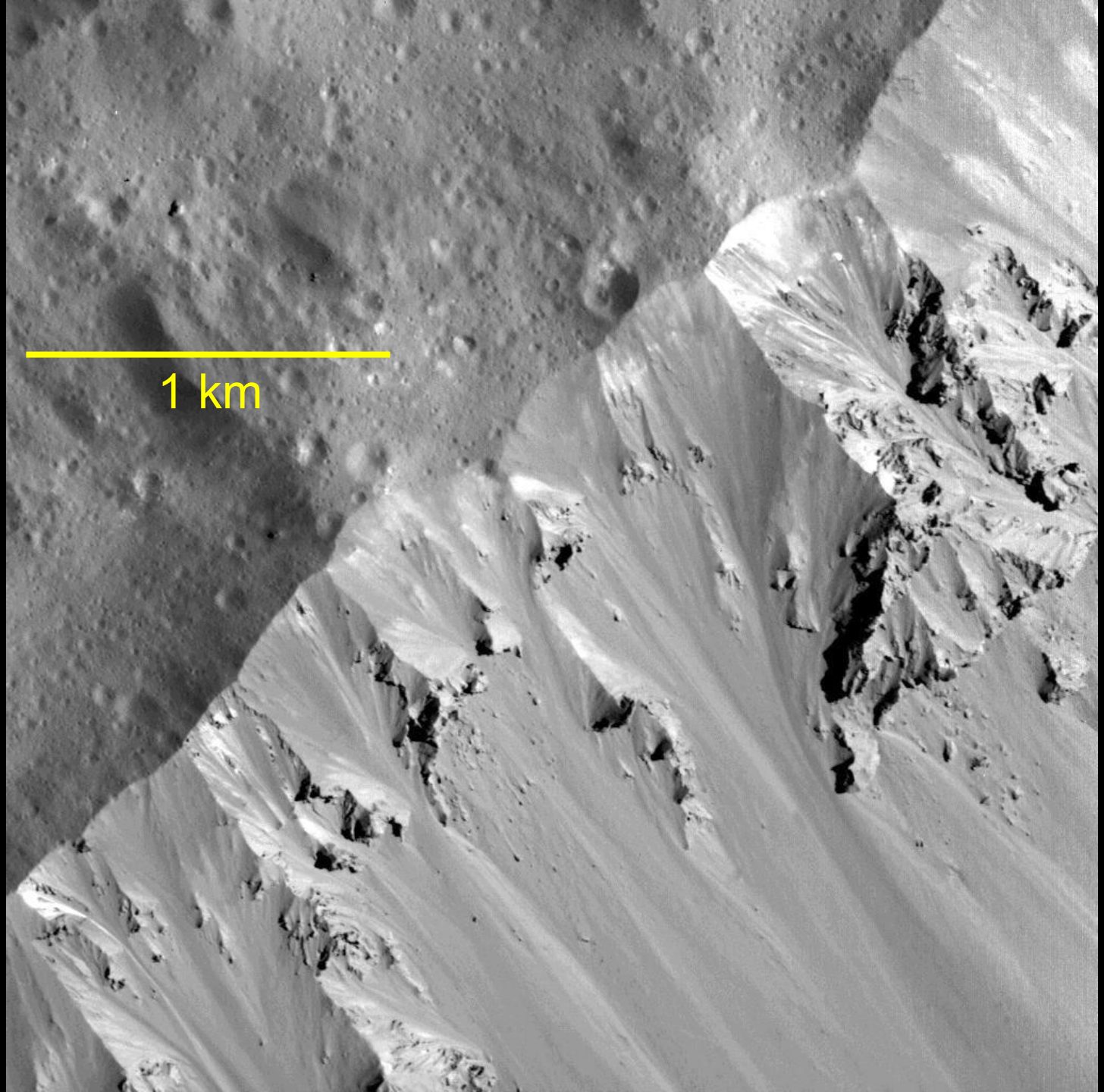
- Images
- IR spectra
- Neutron spectra
- Gamma-ray spectra
- Gravity data

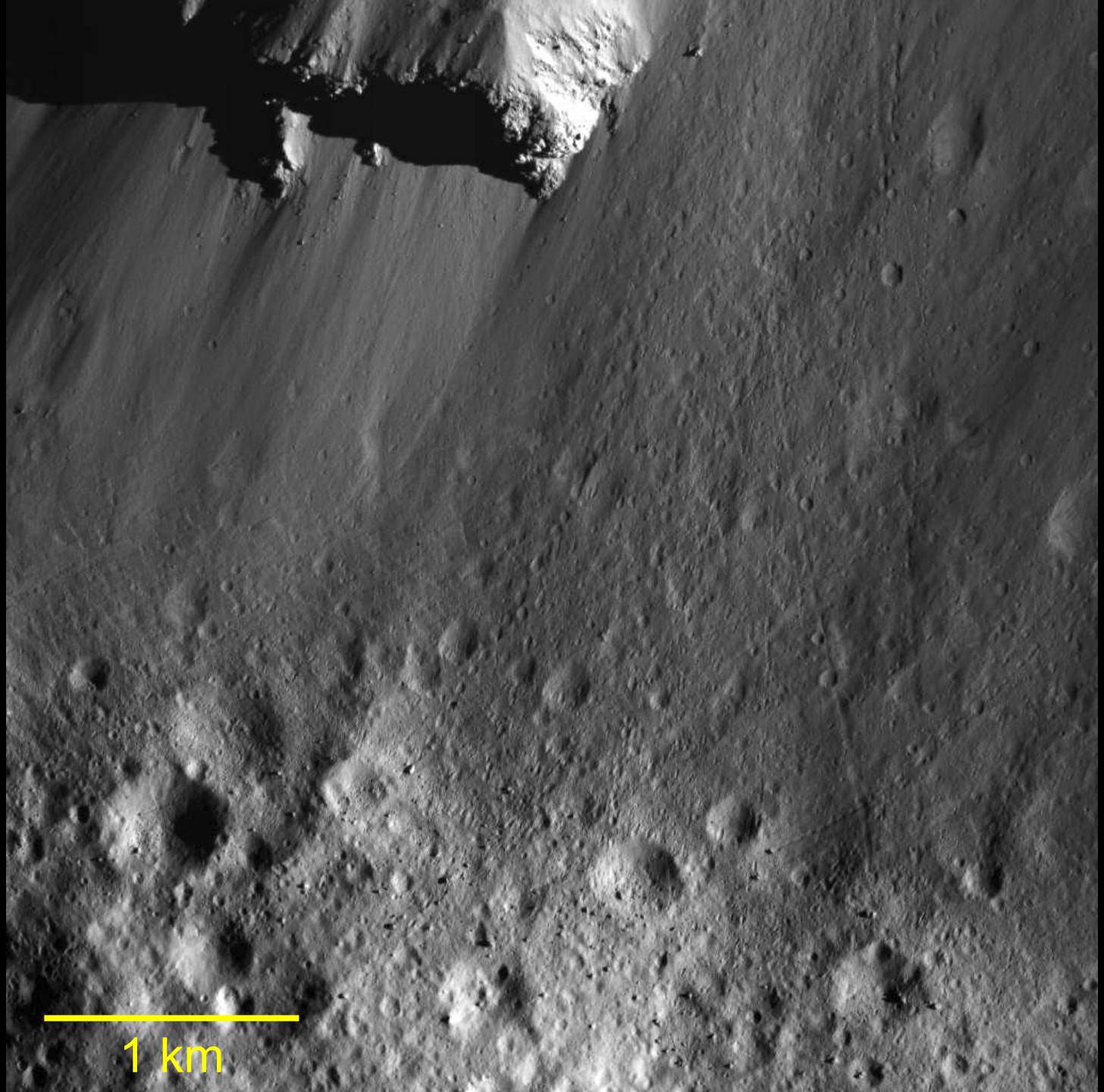

1 km


1 km


1 km


1 km


1 km


1 km

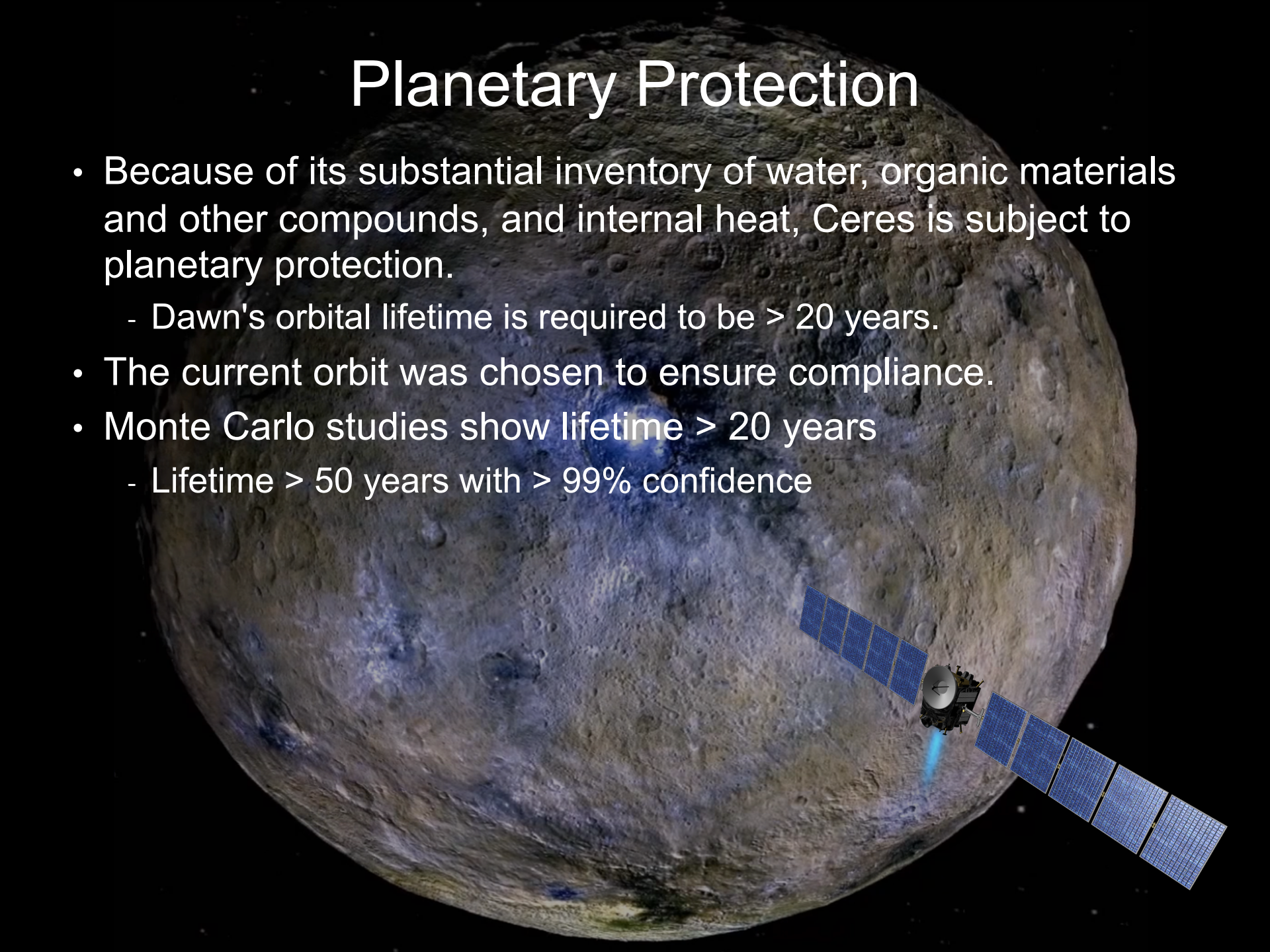
End of Mission

- With no reaction wheel control, Dawn uses hydrazine quickly in this orbit because of
  - High angular rates and accelerations to track the surface through periapsis
  - Gravity gradient torque
- The hydrazine is projected to be depleted between mid-September and mid-October
  - Yes, 2018
- Normal operations will continue as long as hydrazine is available.
- When the hydrazine is depleted, Dawn will lose attitude control and the mission will conclude.

Hydrazine:
The Final Frontier

Planetary Protection

- Because of its substantial inventory of water, organic materials and other compounds, and internal heat, Ceres is subject to planetary protection.
  - Dawn's orbital lifetime is required to be > 20 years.
- The current orbit was chosen to ensure compliance.
- Monte Carlo studies show lifetime > 20 years
  - Lifetime > 50 years with > 99% confidence



Conclusions

- Despite losing reaction wheel control, Dawn has exceeded all of its objectives at Vesta and at Ceres in its prime and two extended missions
- The spacecraft will continue to acquire unique high-resolution data until the mission concludes any moment now.....